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FIRST-YEAR EFFECTS OF LAND TREATMENT ON DRY-SEASON STREAMFLOW AFTER A FIRE IN SOUTHERN CALIFORNIA

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The most dramatic as well as the most frequently devastating effects of fire on watersheds are sharply increased rates of erosion and storm runoff. Increased dry-season streamflow has also been noted in the semiarid Southwest after destruction of the plant cover by fire. In most cases, the natural vegetation was either deep-rooted chaparral or thirsty, canyon-bottom trees and shrubs. Both are relatively heavy water users. This note reports the first-year observations of dry-season streamflow after fire in a basin in which the plant cover had already been altered to reduce water consumption and thereby increase water yield. Except for incidental observations on rainy season erosion, the record of fire effects on storm runoff, flood peaks, and erosion is not reported here.

A fire which swept the San Dimas Experimental Forest in southern California on July 20, 1960, provided an opportunity to study post-fire effects on treated watersheds. Streamflow from the basins had been measured for many years before the fire, including a post-treatment period beginning in 1958. After the fire, measurement was continued until interrupted by the first rain in early October, when an 0.88-inch storm temporarily buried the stream-gaging stations in debris. The measurements showed a sharp change in the flow from the watersheds treated before the fire, but only from treated watersheds--indicating that the treatments had significantly increased water storage in the soil.

At the beginning of 1958, two experimental watersheds had been treated to increase water yield. One was 875-acre Monroe Canyon in which 38 acres covered by deep-rooted, water-loving, canyon-bottom vegetation were cleared and converted to shallow-rooted annual grasses. The other basin was 100-acre Bell Watershed No. 2. In this canyon 40 acres of the side slopes, which contained the deepest soils, were sprayed with herbicidal chemicals to kill the native chaparral cover. Both basins had adjacent "control" watersheds of similar size and geology in which the native vegetation was left undisturbed.

Cumulative precipitation during the 1958-59 and 1959-60 seasons totaled 28.44 inches, just over half the 30-year average.

The July 1960 fire was typically severe, destroying virtually all of the plant cover in the treated basins and their adjoining controls. At the time of the fire the streams were flowing in the two treated watersheds. Flow from the controls had ceased early in the dry-season. A review of streamflow records for similar years in the past, indicates that without the treatment, surface flow from both treated watersheds would also have been expected to cease. In fact, even during years of near-normal conditions before the treatment, streamflow from Monroe stopped in July or by the first week of August. Flow from Bell No. 2 usually stopped about 4 weeks earlier.

Monroe Canyon

The streamflow record from Monroe Canyon for the 4-month period May 20 through September 30, before and after the fire was plotted on the log scale of semi-log paper. This procedure usually produces a straight-line for declining flows. The result in this case was two distinctly different lines: a relatively steep one for the period up to the fire and a flatter line after the fire (fig. 1).

In the 2-months before the fire, the flow from Monroe Canyon decreased from 0.1 acre-foot per day to 0.042 acre-feet per day. Two months after the fire, streamflow was 0.034 acre-feet per day. The rate of change before the fire was equal to a drop of about 10 percent every 8 days. The post-fire decrease was at a rate of 10 percent in 33 days. If the straight line plotted for pre-fire streamflow is extended at the same slope to the end of September, then the difference in rate of surface flow resulting from the fire can be read from the chart. The cumulative difference in streamflow was determined in this manner. From the date of the fire through September 30, this difference was 0.7 acre-feet. Although the quantities of flow involved were small, the rate at which streamflow from Monroe Canyon diminished changed sharply and significantly after the fire.

On August 25, 36 days after the fire, surface flow began through the streamgaging station in the adjacent, control watershed. This flow, however, never amounted to much more than a trickle. At its peak this flow was 8 percent of the volume recorded for Monroe Canyon on the same day, even after adjustment for the difference in size of the two basins.

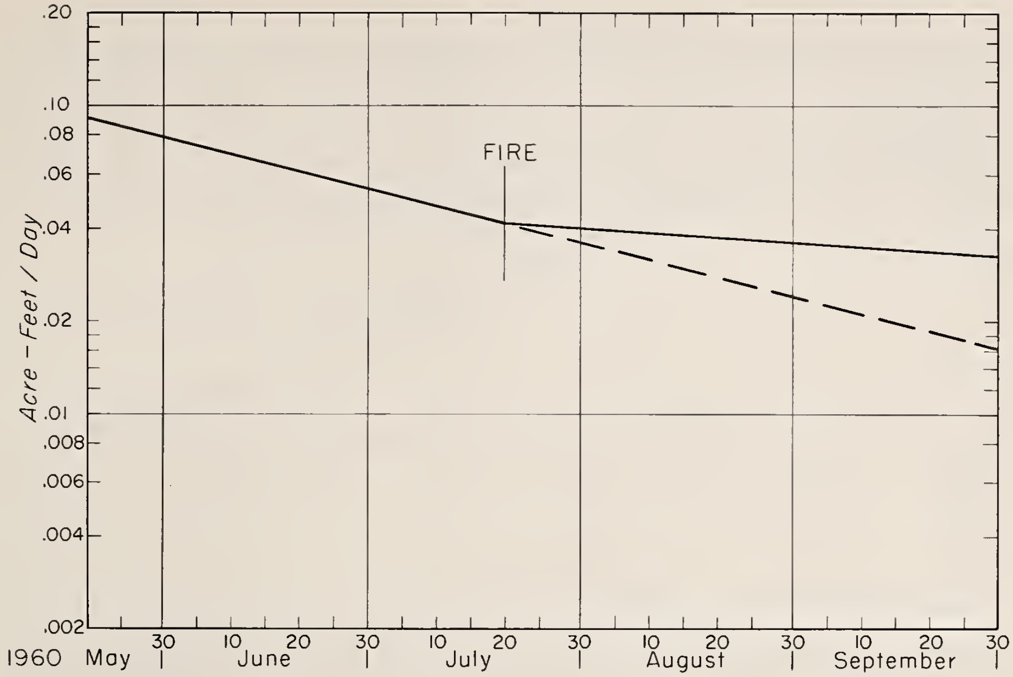

Figure 1.--Streamflow from Monroe Canyon, San Dimas Experimental Forest before and after July 20 watershed fire.

The destruction of the vegetation had effectively stopped the use of water by transpiring plants in both basins, but the streamflow records emphasize an important difference between the two at the time of the fire. A substantially greater amount of water must have been stored in the soil of the treated watershed at the time of the fire.

Bell Canyon

Before the fire, the Bell watersheds were typical dense chaparral-covered headwater basins. In Bell No. 2, 40 acres of brush located on those side slopes which in general had a soil depth greater than 2 feet, had been selected for herbicide treatment. Each spring for three consecutive years before the fire, this area was sprayed from helicopters to kill the brush in place. Dry-season streamflow increased markedly following treatment; moreover, a normally intermittent stream flowed perennially.

Streamflow was plotted over time in the same manner as described for Monroe Canyon. The general trend of the streamflow for the period before the fire represents a drop in flow of 10 percent each 5-day period; after the fire, flow diminished at the rate of 10 percent in 35 days (fig. 2). On September 20, 62 days after the fire, flow was 0.003 acre-feet per day--280 percent of that indicated by pre-fire conditions.

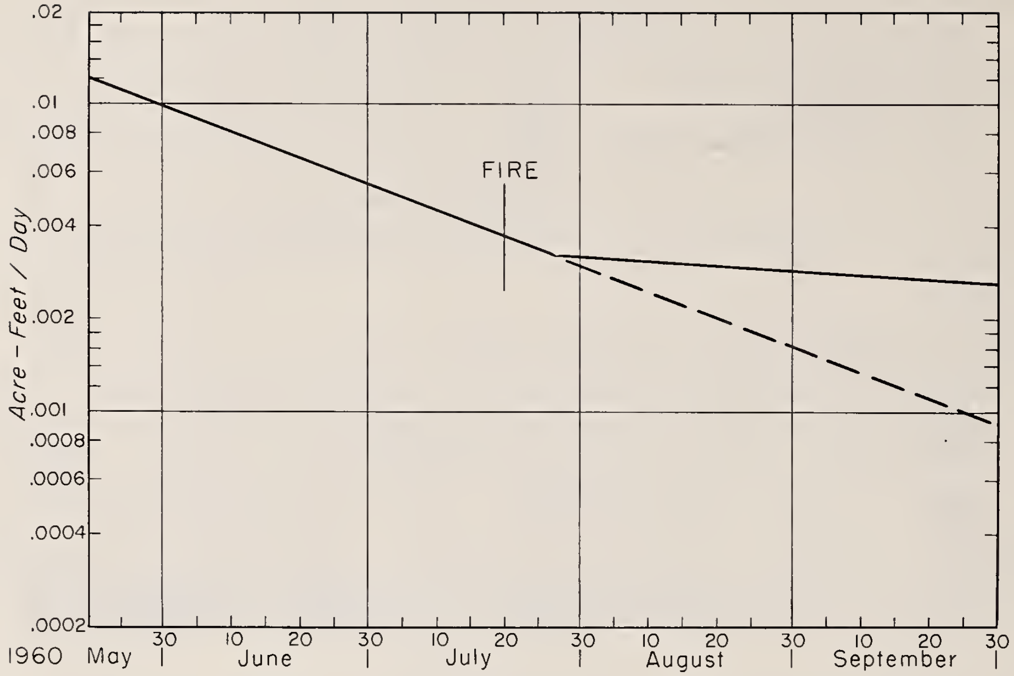

Figure 2.--Streamflow from Bell Watershed No. 2 San Dimas Experimental Forest, before and after July 20 fire.

In terms of absolute quantity of water, the cumulative difference in flow was 0.015 acre-feet. This is indeed a small amount, but then Bell No. 2 is a very small watershed. The point of interest is that after the fire an appreciable change in rate of dry-season streamflow did occur. It is evident that the plant cover which remained in the treated basin, the brush and canyon-bottom trees in the unsprayed areas, and the only partially killed brush plants on some of the sprayed slopes, continued to draw groundwater before the fire. This transpiration loss was at the relatively low rate characteristic of chaparral during the dry-season. The destruction of these remaining plants by the fire interrupted this use and brought about the change in rate of streamflow.

It is of equal interest that surface flow from the adjoining 62-acre control watershed did not resume until the first rain of the season fell in October. This basin was burned just as severely as Bell No. 2; but as a result of the treatment, Bell No. 2, like Monroe Canyon, had more water stored in the soil at the time of the fire.

Discussion

Dry-season streamflow from two treated watersheds increased appreciably the first season after the July 20, 1960 fire; flow from previously untreated watersheds did not. The antecedent treatment had measurably increased water stored in the soil; the burn made more of the stored water available in the form of streamflow. Continued study will show if this increased dry-season flow will continue, how long it will continue, and in what amounts. Erosion and streamflow records will be maintained to appraise the full effects of fire in both dry and rainy seasons. Widespread experience in research and land management in southern California has emphasized the importance of these other aspects of fire.